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Nitres, Inc.

Energy Efficient Solid State Lamp

Need Area(s):

1.1 Lighting Technology: Light Sources

Abstract:

Nitres, Inc., in collaboration with Lawrence Berkeley National Laboratory (LBNL), proposes to develop high-efficiency, high-radiance light-emitting diode (LED) chip and packaging technology that will lead to novel solid-state lamps capable of replacing less energy-efficier incandescent and halogen reflector lamps. Nitres will expand on its leading gallium nitride (GaN) emitter technology and develop novel large area, high-efficiency LED emitters designed specifically for lighting use. The team will develop LED lamp packages for high-power operation up to 30-watts that provide optimum thermal management and optical design. The combined technology developed under this program has the potential of enabling high efficacy, 1500 lumen LED reflector lamps. When compared with current incandescent reflector lamps, this revolutionary new reflector lamp will: a) be three times more efficient; b) have at least ten times the rated life; and c) have greate optical and performance properties. Conventional reflector lamps annually consume approximately 25 billion kWh or 0.27 Quads of electric energy in the United States alone. The proposed technology, at its mature stage, has the potential to rapidly penetrate incandescent / halogen reflector lamp applications, which would lead to predicted energy savings of 0.11 quads by the year 2010. Ultimately, LED reflector lamps have the potential to replace most of the incandescent reflector lamps in the U.S., saving over 0.15 Quads of energy annually. The proposed project will make significant advances in: a) improving the LED materials and device technology; b) increasing th total LED lamp radiance and total input power while maintaining high wall plug efficiency; c) optical designs to enable efficient light utilization; and, d) novel thermal management concepts to provide for low-temperature, reliable LED lamp through effective heat dissipatio concepts. The proposing team is well positioned to tackle these challenges. Nitres will leverage the work with its world leading GaN emitte technology that led to 20% record high quantum efficiency LED emitters and the demonstration of efficient chip level thermal management techniques. LBNL will bring its unique capabilities in materials and optical engineering to bear. The combined effort will lead to the development of key building blocks that will enable revolutionary solid state light bulb technology.

Proposed Team Members:

Nitres, Inc, with support from Lawrence Berkeley National Laboratory

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Rensselaer Polytechnic Institute

Reducing Barriers to Use of High Efficiency Lighting Systems

Need Area(s):

1.2 Lighting Technology: Fixtures, Controls, and Distribution Systems

Abstract:

OBJECTIVES: to significantly reduce the barriers to the wide acceptance and use of energy saving daylighting, electric lighting, and control technologies including occupancy sensors, photosensors, dimming electronic ballasts, integrated skylight/electric lighting systems, and whole building integrated control systems. To work with lighting equipment and control manufacturing partners to develop and bring to market improved, integrated lighting and control systems that will significantly reduce the energy used for lighting in commercial buildings. PROPOSAL: There are significant opportunities to reduce energy consumption used for lighting in commercial applications by advanced means of bringing daylight into buildings more effectively, and controlling the amount of electric-powered light delivered in response to available daylight, occupancy, user needs, and the effects of age of the light source itself. Multiple studies undertaken over the past 20-years have consistently shown that electric energy used to generate light in commercial building can be reduced 25% to 50% using these strategies. However, in spite of these studies, these energy-saving techniques are rarely used in commercial lighting applications in the United States. The Lighting Research Center (LRC) at Rensselaer Polytechnic Institute, in cooperation with its main project partner, Pacific Gas and Electric Company, and lighting equipment-manufacturing partners, will demonstrate integrated systems that will significantly reduce lighting energy consumption in commercial building. These integrated lighting equipment and control systems will capture and use daylight more effectively; include photosensor and occupancy sensor systems that are cost effective, easy to install and commission; and include routes to developing dimming ballasts for fluorescent lamps which are only marginally more expensive than non-dimming high-efficiency electronic fluorescent lamp ballasts. These components will b designed to work together as an integrated lighting system, while operating and communicating effectively with other building systems. The human factors aspects of each of the energy-reduction technologies will be evaluated to insure their design is consistent with the needs and preferences of building occupants. As a part of this overall effort, the project will use the proven resources of the LRC to inforn and educate lighting users and specifiers about the value and proper use of this valuable energy-saving technology.

Proposed Team Members:

Rensselaer Polytechnic Institute, with support from the Pacific Gas and Electric Company

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Electric Power Research Institute (EPRI)

Advanced Light Source Development: Multi-Photon Phosphor Research

Need Area(s):

1.1 Lighting Technology: Light Sources

Abstract:

Principal Project Goal--This project concentrates on one aspect of the ongoing EPRI multi-disciplined collaborative research program, that being the specific area of multi-photon phosphors in low pressure fluorescent electric discharge light sources. The goal is to focus on breakthrough basic research required to achieve doubling of the current efficacy to 200 lumens per watt for commercially applicable light sources. This proposal is to conduct a decisive explorative study of phosphors exhibiting multi-photon emission in the visible part of the spectrum. This work will be carried out utilizing a targeted group of researchers highly experienced in the multiple science and engineering disciplines involved in multi-photon phosphor research. Depending on the outcome of the exploratory work, recommendations will be mad for specific future research and the potential for achieving the overall performance and efficiency goals. Contributing Project Objectives: 1) Recent breakthroughs have been reported in multi-photon emission from Gd and Er-based fluorides and cascade emission from Pr in oxides. Explore the physics and chemistry of designing such multi-photon phosphor systems and extending similar concepts to new host-impurity combinations. 2) Identify, examine and categorize new multi-photon concepts; use theoretical analysis and modeling to aid in evaluating the validity of the concepts. 3) Determine the compatibility of such phosphor systems with spectral requirements of commercial fluorescent lamps. Determine the potential gain in energy efficiency in both Hg-free and Hg discharge lamps. 4) Evaluate the feasibility of synthesizing the key candidate phosphors, and the coating of such phosphors on lamp envelopes. Methodology: This multi-photon phosphor research project is based upon utilizing specific in-place resources of the EPRI advanced light source research consortium in combination with a select group of expert consultants. The multi-step feasibility process includes: an initial state-of-the-art presentation and exchange workshop; a follow-on assigned and tracked feasibility research phase by each of the expert teams; a results reporting and consensus development workshop; and a final report completion. Participating Organization: EPRI is the principal participant. Other collaborating organizations include LANL and Osram Sylvania.

Proposed Team Members:

EPRI, with support from Los Alamos National Laboratory (LANL), Gough and Associates, and Osram Sylvania

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Fusion Lighting, Inc.

Next Generation High Efficiency Lighting Technology

Need Area(s):

1.1 Lighting Technology: Light Sources

Abstract:

The intrinsic bulb efficacy of a microwave-powered sulfur lamp is far higher than any commercially available light source. Further, the sulf bulb has other important advantages including: a) high brightness, which permits very efficient delivery of light; b) excellent, full spectrun color, which permits enhanced visual acuity and reduced electrical requirements for many tasks; and, c) very long potential life with almos no change in light output or color. In order to take practical advantage of sulfur, a more robust and cost-effective lamp system must be engineered. That engineering and testing of that lamp, called the BrightDrive™, is the subject of this proposal. The proposer, Fusion Lighting, Inc. has demonstrated in the laboratory a new design for a sulfur lamp, which resolves most of the shortcomings of the previous design. It utilizes a new, higher efficiency microwave tube and power supply, and a fully sealed volume surrounding the bulb and initial optical cavity. In the first phase of this proposed work, the critical subassemblies of the lamp system will be analyzed, designed and teste under extreme conditions of temperature, humidity, and electrical inputs, in order to identify their vulnerabilities and redesign to reduce them. In the second phase, the entire lamp will be assembled, thermal and packaging issues will be resolved, and lamp systems will be subjected to accelerated stress testing as well as standard life tests. In the third phase, the lamp will be adapted to a variety of fixtures and light distribution systems including a low-cost light pipe under development by Fusion Lighting. Sample systems will be placed at key demonstration sites and their performance will be monitored. In success, the Company will undertake a full-scale commercialization effort. Estimates indicate that the use of cost-effective BrightDrive lighting systems can reduce the energy used in lighting in the US by 15% by the year 2012.

Proposed Team Members:

Fusion Lighting, Inc., with support from Simpson and Wooten

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General Electric Corporate Research and Development-Niskayuna

Organic Light Emitting Diodes for General Lighting

Need Area(s):

1.1 Lighting Technology: Light Sources

Abstract:

According to the US Department of Energy, lighting accounts for 15% of the total energy used in the US and 23% of the electricity consumed in the buildings sector. In terms of total energy usage, fluorescent lamps dominate the indoor general lighting market and hence improvements over this technology present the biggest potential for energy savings. Fluorescent lighting technology is mature and hence the rate of progress in improving energy efficiency over the past decades has been low. In contrast, the rate of progress in solid state light emitting technologies over the past decade has been enormous. Thus, it is now possible to envision the development of a new solid state light source with higher energy efficiency than has been achieved with fluorescents. The solid state technology with the best chance of displacing fluorescent technology is the organic light emitting diode (OLED). This technology possesses the critical combination of potentially high energy efficiency and low cost that is required to penetrate the general lighting market. OLED technology has been actively developed by the flat-panel display industry as a replacement for liquid crystal displays but, to date, not much effort has gone into developing OLEDs for general lighting. This is due to a more uncertain return on investment caused by formidable technical risks and a longer time horizon for commercial application. GE Corporate Research and Development is proposing a three year program to reduce the long term technical risks that are keeping the lighting industry from embracing and developing this potentially energy saving technology. The specific goal is a demonstration light panel that delivers white light with brightness and light quality comparable to a fluorescent source and with an efficacy better than that of an incandescent source. This will require significant advances in three areas – (a) improvement in OLED energy efficiency at high brightness, (b) improvement of white light quality for illumination, and (c) the development of cost-effective large area fabrication techniques. Achievement of the project goals will demonstrate that OLED technology can impact general lighting and will spur the level of investment needed to develop a commercially viable OLED light source. If such an OLED light source can be developed, the potential for energy savings is enormous – 0.86 quads per year. Other benefits that would accrue include a reduction of carbon dioxide emissions by 13.5 million metric tons per year and an elimination of 1180 kg of mercury waste per year.

Proposed Team Members:

General Electric Corporate Research and Development-Niskayuna

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Rocky Research

Advanced Thermal Expansion Devices for Reduced Cycling Losses and Improvement Efficiency in Heating and Cooling Equipment

Need Area(s):

2.2 Space Conditioning Equipment: Distribution, Storage, Control, and System Integration

Abstract:

Current technology used for the control of refrigerant flow to the evaporator in small capacity, less than 18,000 BTU/hr, air conditioner systems such as Packaged Thermal Air Conditioners (PTACS), trailer home air conditioners, and window air conditioners is mostly based use of capillary tubes. Capillary tubes are sized for a single capacity point and operating temperature and their use results in a performance loss at part load, off-design temperatures, and during start-up. Losses can be avoided if an active system (electronic solenoid valve) or a passive system (pressure controlled diaphragm thermal expansion device) is used. Electronic solenoid valves are prohibitive in cost and reliability. Today's modulating TXV technology for larger equipment can not be scaled down without severe technical compromise on system performance and first cost penalty to the system. Current larger Thermal Expansion Valves (TXV), used in the range of 2-5 ton capacity, are of modulating design which can not response sufficiently fast to demand/load changes and response often lags the flow requirement, causing the so-called "hunting TXV" problem. These "hunting problems" are of concern to commercial HVAC manufacturers such as Lennox Industries Inc. There is an opportunity to enhance the larger capacity residential and commercial thermal equipment efficiency and performance by using the proposed pulsing Thermal Expansion Valve (TXV). Proposed herein is the development to commercialization of a patented TXV, U.S. Patent 5,675,982, Pulsed Operation Control Valve, issued 10/14/97.

This valve is different to a "traditional" TXV in such that it is designed to pulse rather than to modulate the orifice size. Pulsing operation ensures fast response and correct refrigerant flow to the evaporator with reasonable valve component dimensions and cost effectiveness. In addition the use of a capillary tubes and conventional TXVs results in pressure equalization between the high-pressure side and low-pressure side during system shutdown. This equalization has a large energy penalty in cyclic operations since the compressor spend part of the start-up period to restore the required pressure difference. The current TXV will positively seal when the compressor is off, maintaining the pressure difference. This in turn results in shorter startup period and higher energy efficiency.

The pulsed TXV has demonstrated proof of performance improvement as replacement of capillary tubes in refrigeration equipment such as vending machines, refrigerators and freezers appliances. These improvements, which are due to reduced cycling losses and improved pull-down, result in significant energy conservation. During the proposed effort, performance enhancements pertaining to several differer building air-conditioners/heat pumps will be established. Lennox Industries Inc. has reviewed results on appliances and anticipated result in HVAC equipment and decided to participate in the proposed effort as shown in the attached Lennox letter. Lennox will also supply Rock Research with suitable HVAC equipment for testing. Once the performance enhancement is quantified, cost and reliability will be determined. Bergstrom Inc., a leading manufacturer of climate control systems for the commercial vehicle industry and valve manufacturer, will support Rocky Research in cost effective design for manufacture. Lennox's expertise will be used to assess opportunities to minimize component inventory cost for HVAC system assembly and optimize valve integration. Several test setups will be designed for reliability tests to address issues such as diaphragm and spring life. The proposed schedule for this effort is about 18 months and $413,069 with $82,800 of it provided as cost share.

Proposed Team Members:

Rocky Research, with support from Lennox and Bergstrom

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Davis Energy Group, Inc.

Hypak--A Hydronic Rooftop Packaged Unit

Need Area(s):

2.1 Space Conditioning Equipment: Energy Conversion Efficiency

Abstract:

OBJECTIVES: The major project objective is to develop a cost-effective, hydronic rooftop packaged HVAC unit that reduces HVAC electrical energy consumption and peak demand compared to current rooftop units (RTU's) by more than 65% in dry climates and 50% in humid climates. More specific objectives include developing and demonstrating a "HyPak" RTU design that: 1) reduces compressor energ consumption by using an evaporatively-cooled condenser; 2) includes a new high performance counterflow evaporative water cooler that also functions as a ventilation air pre-cooler and an exhaust air heat recovery device; 3) delivers all heating and cooling through a single hydronic indoor coil to reduce pressure drop; 4) places the indoor coil and blower below the roof to straighten the air path, reduce blower energy use and eliminate the rooftop cabinet heat gains and losses of current RTU's; 5) delivers evaporatively-cooled water to the coil with compressor off when conditions allow; 6) controls latent cooling by varying coil inlet water temperature and air flow rate; 7) reduces blower energy use by incorporating efficient variable-speed motors; 8) includes filtration and automatic diagnosis/treatment of the hydronic loop water; 9) uses on-board electronics to monitor and report electrical consumption and thermal delivery; 10) can connect with hydronic radiant floor tubing to improve comfort and energy performance by warming the floor in winter and using the floor mass as an off-peak cooling thermal storage medium in summer; and, 11) enhances indoor air quality by improving air filtration and controlling ventilation air flow rate.

METHODOLOGY: The HyPak project will achieve its objectives by advancing the technology from the exploratory development stage through both advanced and engineering development stages. Exploratory stage tasks will include developing the counterflow evaporativ water cooler, designing an initial unit configuration, developing performance and cost models, estimating HyPak economics, and developing an "end-of-stage" assessment of HyPak's viability. Advanced development efforts will fabricate and demonstrate a working HyPak prototype, including tasks to develop detailed drawings, fabricate and laboratory test a prototype, conduct focus groups to gather stakeholder input, and update the assessment of HyPak's viability. Engineering development work will test a refined HyPak unit in response to real operating conditions, including tasks to refine the design, build and laboratory test a fieldable unit, and install and field test the unit. A project report will summarize project work and present a final assessment of HyPak's viability and commercialization prospects.

Proposed Team Members:

Prime Contractor Davis Energy Group (DEG) will have primary responsibility for achieving overall project goals, and for managing work in the exploratory development stage, where DEG's conceptual design skills are most valuable. Subcontractor Des Champs Laboratories (DL the potential HyPak manufacturer, will assume the major role in the advanced development stage, where DLI's product design and production skills are most essential. Subcontractor Arthur D. Little (ADL) will assume the major role in the engineering development stage to capitalize on ADL's expertise at optimizing products for manufacturing. Subcontractor Lawrence Berkeley National Laboratory will participate in all three stages to assure state-of-the-art air systems that maintain indoor environmental quality.

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NRG Technologies, Inc.

Development of Low Cost Total Energy Exchange Devices for Reducing Building Energy Consumption

Need Area(s):

2.0 Space Conditioning Equipment

Abstract:

This proposal is in response to Need Statement 2.0, Space Heating, Cooling and Ventilation Equipment and falls into DOE's Technical Maturation Stages 3, 4, and 5. ASHRAE Standard 62-89 addresses the need for improved indoor air quality (IAQ) by requiring increased amounts of outdoor ventilation air to be introduced into buildings. In implementing the standard, energy savings programs for buildings have taken a backward leap. Space conditioning loads, especially the latent portion in humid regions, have increased with the required increased levels of ventilation air and conventional air-conditioning (A/C) systems have unable to handle the loads efficiently. In some instances IAQ has actual deteriorated because increased moisture in buildings has exacerbated mold and mildew growth. DOE has been addressing the latent load and energy issues by evaluating the market for and benefits of desiccant systems. Conclusions from three separate DOE sponsored studies, referenced in this proposal, point to the superiority of passive enthalpy exchange devices for reducing energy usage in buildings and improving IAQ. The overall goal of this program as it relates to DOE's mission is to reduce energy use in buildings while assuring acceptable indoor air quality. One study estimates that 0.42 quads of energy could be saved in the U.S. alone through the use of enthalpy wheel preconditioner products. To encourage broad market acceptance, NRG Technology's primary objective is to develop a low-cost, high efficiency enthalpy wheel media that can be produced at an OEM cost as low as one fifth of the cost of the media manufactured using current technologies. The major problem with current generation enthalpy exchange devices is the relationship between cost and efficiency. Low cost devices are available, but fail to achieve adequate efficiency. Units that achieve the high efficiencies necessary cost more than the current market can support. To overcome this situation, NRG Technologies intends to integrate inexpensive desiccant and matrix materials into high speed manufacturing processes. Surprising results from recent modeling studies indicate that the currently used desiccants and matrix materials do not offer the best combination of cost and performance. Better materials selection will be made and proprietary methods will be used to combine the matrix and desiccant into a low-cost composite that is compatible with high speed manufacturing processes.

Proposed Team Members:

NRG Technologies, Inc. will utilize several outside organizations that have specialized equipment for corrugation, wheel winding, cassette manufacture and performance testing. The Institute of Paper Technology (Atlanta) will be used for corrugation work and the University of Illinois, Chicago will be used for matrix and wheel testing. NRG Technologies intends to demonstrate, through this project, the superior cost-performance of our technology. It is our intention to either license the technology to an existing enthalpy or desiccant wheel manufacturer, such as NovelAire Technologies, LLC, or to raise the necessary capital and manufacture wheel cassettes in-house for sale t current HVAC OEMs.

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General Electric Corporate Research and Development-Niskayuna

Variable Speed Integrated Intelligent Blower for High Efficiency HVAC

Need Area(s):

2.0 Space Conditioning Equipment

Abstract:

Every year a considerable amount of energy is wasted due to the inefficient operation of commercial and residential heating, ventilation and air conditioning systems (HVAC). The Department of Energy (DOE) has estimated that HVAC, by far the largest consumer of energy i buildings, accounts for 6.7 Quads of energy consumed per year in the U.S. at a national cost of more than $150B. One of the best opportunities for reducing the energy consumption of HVAC is to improve the air handling and distribution system. Based on DOE data, more than 14% of the residential HVAC and 25% of the commercial energy consumption can be attributed to air handling equipment – primarily fans and motors which by themselves account for 1.23 quads and the equivalent production of 19.3 million metric tons of carbon emissions. The variable speed Electronically Commuted Motor (ECM) motor introduced several years ago by GE has been one of the few significant technical advancements in residential and commercial air handling systems. Today's most efficient two stage residential furnaces are dependent on the variable speed ECM that have a 2:1 efficiency advantage over the single-speed induction motor. The ability to vary fan speed depending upon HVAC usage cycles can significantly reduce the electrical energy consumption by 75-80% for a 3-5 ton residential 2-stage HVAC application since the blower will run at 60% of full rated speed for 90% of the time and the consumed power in an ECM varies with (speed)3 . While a number of commercial air handler vendors (e.g. Nailor) and residential furnace/air conditioning vendor (e.g., Trane, Carrier, and others) incorporate variable speed blowers into their products, the penetration and installed base of two stage equipment with variable speed blowers is still quite low; e.g. only 7% of residential HVAC system employ variable speed blowers. Several reasons for the lack of penetration have been the cost of a variable speed blower along with the more complex installation procedures associated with the technology. The overall efficiency of an ECM driven blower has also been compromised by poor fan and shroud designs that reduce the overall efficiency. To address these issues GE has assembled a team that unites several major vendors of HVAC sub-systems with one of the U.S's leading industrial R&D laboratories. This team, consisting of GE Research and Development, GE Industrial Systems, Revcor, Trane, Carrier, and Nailor has the expertise and desire to substantially increase the efficiency of air handling systems which currently account for more than 14% of the energy losses in commercial and residential HVAC systems. The GE team is uniquely qualified to conduct this proposed program. GE CRD has been a world leader in the development of motor, blower, power electronics, and packaging technologies. GE Industrial Systems is the world's number one supplier of motors for in-dustrial and HVAC applications. Revcor is the leading manu-facturer of fan assemblies in the U.S and is planning to enter a teaming agreement with GE Motor to develop innovative air handling products. Carrier, Trane and Nailor are all significant manufacturers of HVAC generation and distribution equipment. This team brings together, for the first time, not only a strong group of researchers and engineers capable of developing more efficient air handling and distribution technology, but also a group of leading HVAC vendors who are in a position to leverage the technology directly into products that will make a difference relative to U.S. energy consumption. The GE team proposes to develop and demonstrate a variable speed Integrated Intelligent Blower that combines the fan, shroud, and motor/drive assembly into a common structure. The Integrated Intelligent Blower will take advantage of advancements in the design of the individual fan, motor, and power electronics/packaging components to provide more than a 2-fold reduction in electrical energy consumption while reducing the overall cost by 30%. The integrated design of the motor and fan will result in a more mechanically balanced structure that reduces noise an bearing wear and is attractive to the HVAC industry. In addition, the features of a DSP-based ECM sensorless position control allows a range of blower and air distribution diagnostic features to be built in without the need for additional sensors. This added "intelligence" wil provide self-calibration and real time diagnostics capabilities that overcome set-up difficulties and allow the blower to maintain optimum performance over it's lifecycle. This program is being proposed as a two-year effort. In the first year, GE and Revcor will work closely with Trane, Nailor, and Carrier to establish specifications for the Intelligent Integrated Blower in order to meet performance and retrofit requirements into existing blower package footprints. A conceptual design of the integrated assembly will drive the requirements for the individual components. Using a six-sigma approach that flows down the overall requirements to the individual component technologies, a combination of accurate simulation using GE-CRD air flow, motor, and power electronics modeling tools and experimentation will be used t the optimize fan, motor, and power electronics. Several innovative motor, power electronics, and packaging approaches for designing a lower cost, more efficient ECM will be evaluated. In Year 2, a fully integrated blower taking advantage of all the technology enhancements will be prototyped and tested at GE Industrial Systems and Revcor. Final evaluation of the technology will take place at Nailor, Trane, and Carrier with the Intelligent Integrated Blower installed into representative HVAC air handler assemblies. This program will result in an overall savings of 0.3 quads over the next 3-5 years (30% market penetration), based upon a) the lower total electrical energy consumption of a 2-stage HVAC system, and b) an average increase in fan efficiency from 37.54% to 77.5, motor efficiency from 82.5% to 87.5%, and power electronics drive efficiency from 93% to 94.5% for the Intelligent Integrated Blower. This energy savings corresponds to a reduction of 4.1 million metric tons in carbon emissions.

Proposed Team Members:

GE Research and Development, GE Industrial Systems, Revcor, Trane, Carrier, and Nailor

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North Carolina Advanced Energy Corporation

Field Study Comparison of the Energy and Moisture Performance Characteristics of Ventilated vs. Sealed Crawlspaces in the South

Need Area(s):

3.1 Building Envelope: Building Materials and Envelope Systems

Abstract:

The purpose of this field test is to conclusively demonstrate that sealed crawlspaces offer measurable benefits over traditional, ventilated crawlspaces. The field test will be undertaken to provide persuasive measured data and analysis comparing the performance of sealed versus ventilated crawlspace systems. Until this data is assembled, wide market acceptance of sealed crawlspace technology will continue to be denied by building code organizations and the residential construction industry. The commercialization of this technology will be achieved by developing diverse and varied outreach tools describing the project results. The field test results and design guidelines will b packaged and delivered so as to convince the key stakeholders to embrace sealed crawlspaces as a standard building practice. The potential impact of this field study is large, since it promises to revolutionize one of the most popular residential foundation practices, particularly in the Sunbelt states. The potential energy and related carbon savings--though significant--are believed to be secondary relative to the immediate home moisture, durability and indoor air quality improvements that sealed crawlspaces promise. Sealed crawlspac technology is applicable to new and existing single family and low rise, multifamily housing construction. The project area of interest is th U.S. South Census Region where ventilated crawlspaces account for 50% of the foundations used in single family, detached housing. Field-testing will be conducted in the two predominant climate types of the South: the mixed heating and humid cooling climate found in th northern and central areas of the south, and the hot and humid cooling climate found in coastal areas. Advanced Energy Corporation's Applied Building Science Team will conduct the field test. Key team members include nationally recognized building science experts John Tooley, Frank Vigil, Bruce Davis and Arnie Katz. Oak Ridge National Laboratory's Building Technology will perform the energy and moisture performance analysis under the supervision of senior scientist Achilles Karagiozis. Rounding out the project team are recognized experts in building and foundation moisture and indoor air quality (Terry Brennan from Camroden Associates, Dr. Wayne Thomann from Duke University Medical Center and Antoni TenWolde from Forest Products Research Laboratories) as well as a team of volunteer technical advisory committee members that will be help refine and improve the testing protocols and scope of work. The study is organize into six tasks. The two major tasks, which account for approximately 60% of the budget will be a characterization of existing conditions performed on 50 homes and a controlled experiment field study involving 70 crawlspaces over two cooling seasons and one heating seasons. Four categories of crawlspace designs will be evaluated: Ventilated crawlspaces (as a control group) and three levels of sealed technologies: Low cost, sealed crawlspaces, sealed crawlspaces with wall insulation versus floor insulation, and sealed crawlspaces coupled with advanced technology. Major emphasis will be placed on evaluating high performing, low cost technologies. This focus is to identify practical, market driven technologies that the shelter industry can quickly, affordably and readily adopt. The field test results will be summarized a wide variety of formats including a research paper, guidelines and construction details, technical bulletin, overhead presentation, video trade articles. This information will be presented at conferences and industry meetings as well as mailed directly to key stakeholders. The proposed project falls under the category of Technology Maturation Stage 5 - Engineering Development. The level of effort needed to conduct the field test amounts to 974 person days.

Proposed Team Members:

North Carolina Advanced Research Corporation, with the support of the Oak Ridge National Laboratory, Camroden Associates, Duke University Medical Center and Forest Products Research Laboratories

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Schott Donnelly, LLC

Development of Durable Large Area Electrochromic (EC) Glazing

Need Area(s):

3.2 Building Envelope: Windows

Abstract:

This program is directed towards improving the cyclic durability of electrochromic (EC) windows and demonstrating devices in size of abo 2' x 2' for architectural applications. The technology principles used in demonstrating this size will be the foundation for further size scale up. The program will focus on improving (EC) devices in terms of optical performance, durability, manufacturability and size scale-up at an attractive cost. The presently proposed program will build upon Schott Donnelly's many advances in the area of electrochromic technology. This advance concerns the demonstration of durable EC devices at elevated temperatures under UV irradiation. These cells have been independently tested and performance confirmed both at Schott Donnelly LLC and the National Renewable Energy Laboratory (NREL).

The program is directed to addressing the technical issues necessary to make EC technology usable for large-area architectural windows and to demonstrate both the reliability and the lifetime of the glazing consistent with Technical Maturation Stage 4 of the DOE proposal. Included in the technical program are investigations of electrode materials, internal busbars, electrolytes, seals and cell assembly. By the end of the program it is envisaged that a prototype EC window will be demonstrated for architectural applications.

Schott Donnelly LLC is in a fortunate position in that it can tap into the vast experiences of two companies namely the Schott Corporation and Donnelly Corporation. Schott is a world leader in depositing optical quality coatings on architectural glass and is the only manufactur who has successful adopted a wet chemical deposition method to coat large areas. Donnelly on the other hand is one of two principal suppliers of electrochromic mirrors to the world automotive market, and thus has broad experience with the commercial production of automotive-hardened and cost-effective electrochromic devices and with the creative combination of chromogenic cells with appropriate sensors and controls.

Challenges with EC devices include increasing the area, improving cyclic durability, maintaining acceptable optical performance and lowering cost. Schott Donnelly's LLC (SDL) vast experience in EC technology and proven EC cell design holds great promise for long tern durability, low-cost manufacturability and uniform coloration in a large area application. Because of Schott Donnelly's active participation in large area electrochromic glazing development, it is uniquely positioned to succeed in this program.

The market penetration for architectural applications by SDL will exceed $100 million annually within the first four years of introduction. Besides the great commercial potential of such a market, the introduction of EC glazing into the architectural sector would greatly increase consumer comfort, decrease the air conditioning load on buildings and accommodate the desire of architects for increasing the glass content of buildings, and would provide a real leadership position for American technology in this area.

Schott Donnelly LLC is firmly committed to developing EC technology for building applications and to its commercialization. With DOE continued support, and with success in the technical program, Schott Donnelly LLC will commit further resources to achieve this goal.

Proposed Team Members:

Schott Donnelly, LLC

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Aerodyne Research, Inc.

Non-Intrusive Sensor for Gas Fill Verification of Insulated Glass Windows

Need Area(s):

3.2 Building Envelope: Windows

Abstract:

The overall objective of the proposed project is the development of a sensor which can verify the proper gas filling of Insulated Glass (IG) windows in a non-intrusive and non-destructive manner. It also addresses the need for a field-based sensor which will determine if windov seal damage has occurred. This sensor can be adapted for production quality control (testing for complete substitution of air by argon or other such low thermal conductivity gas), evaluating inventory units, and most importantly, used to test IG window integrity in the field. Studies indicate that fully half of all new IG windows being produced do not meet their specified argon fill levels resulting in a significant loss of energy reduction potential for gas filled insulated glass windows. That loss is estimated, by the year 2010, to total .035 quad of energy yearly at a cost of over $200 million just in the United States alone. This lost energy reduction also results in the emission of a half metric ton of carbon into the atmosphere resulting in increased global warming potential. Increased NOx and SOx (oxides of nitrogen and sulfur) levels caused by the extra power generation also contribute to air pollution. Because of legal liability issue, the industry may have to drop the entire practice of gas filling. If so, the energy losses and concomitant increase in carbon emission levels would increase by a factor of four. There is also a significant failure rate for windows already installed in residential and commercial buildings. A sensor which could detect window seal failure in situ and concomitant loss of gas fill could also result in significant energy savings for the United State The basis for this sensor is a patented technology [U.S. Patent #5,650,845, (July 22, 1997)], assigned to Aerodyne Research, which provide for the detection of oxygen (a major component of air) by means of measurement of optical absorption of near visible light. This novel monitor utilizes optical absorption of an emission line emanating from a simple gas discharge lamp that coincides with a feature in the oxygen absorption band in the near visible (~760 nm). (We note that neither nitrogen nor argon can be readily detected using optical absorption spectroscopy. This technique would require the use of vacuum ultraviolet light below 150 nm, wavelengths which are not compatible with window glass.) Detection using light of this wavelength permits the use of optical fibers to link a light source/detector module with a remote measurement module. Furthermore, the measurement technique can be made non-invasive and non-contact - an advantage over existing oxygen monitoring techniques such as solid state sensors (which also require elevated temperatures), paramagnet sensors and electrochemical cells. (An added feature is that the sensor is also capable of measuring water vapor simultaneously.) The proposed project involves a collaboration between Aerodyne Research, Inc., a small business which focuses on atmospheric sensor development, and FDR Design Inc., a small business which is the major seller in the U.S. of gas filling equipment to the fenestration industry, and Hurd Millwork Company, Inc., a producer of windows and patio doors.

Proposed Team Members:

Aerodyne Research, Inc., with the support of FDR Design Inc. and Hurd Millwork Company, Inc.

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Aspen Systems, Inc.

Affordable Window Insulation with R-10/inch Rating

Need Area(s):

3.2 Building Envelope: Windows

Abstract:

The objective of the project is to develop a process and equipment to produce continuous sheets of transparent, resilient, hydrophobic aerogel. These sheets will have the performance rating of R-4/cm (R-10/inch) and will be used to produce clear glass double-glazing windows with R-6 rating at prices affordable for most homes and buildings, as retrofits or new installation. This is double the ratings of the most widely used double glazing windows today at prices attractive to a majority of the homeowners and builders. In March 1999, Aspen Systems, Inc. invented an economical aerogel drying process that could be up to 30 times faster than existing supercritical CO2 processes without degrading the properties of aerogels. Now, aerogels, the best solid insulation mankind has ever made, would be produced at low enough costs to be introduced, on a large scale, as insulation for homes and buildings in addition to many other uses in aerospace, clothing, computers, cryogenics, refrigerators, etc. The combined revenues from these aerogel products will reach several billion dollars a year worldwide. The projected National Total Energy Savings is 0.53 Quads and the projected total carbon emission reduction is 8.11 x 10 6 metric tons. Aspen received 1999 SBIR Technology of the Year Award in Manufacturing and Materials for this important technical breakthrough. A 1000-liter pilot plant based on the new process is scheduled to be operational by the end of March 2001. Aspen also developed a formulation for hydrophobic aerogels with glass-like transparency of 93%/cm (83%/inch) under an on-going DOE SBIR Phase II project to develop superior Cherenkov detectors for particle physics research. Under the current project, this transparent/hydrophobic aerogel formulation will be modified to give slight resiliency necessary for windows application. Also, a sheet making accessory equipment will be designed, fabricated and attached to the1000-liter pilot plant for production of transparent and resilient aerogel sheets for window insulation. The pilot plant would ultimately be capable of producing 900 m 2 (9,500 sq.ft) of 40 cm (16 inch) wide, 6.35 mm (¼ inch) thick transparent aerogel sheets a day. The additional cost to the windows manufacturers is $19/m 2 for incorporating 12mm (1/2 inch) aerogel sheet. The projected payback period for the new windows with 12.7 mm (1/2 inch) aerogel layer and R-6 rating is less than four years. Due to the short payback period, the new superinsulated windows will be used widely both as retrofit and in new constructions. This project, funded by DOE's Office of EERE (Energy Efficiency and Renewable Energy) through NETL (National Energy Technology Laboratory), constitutes an important part of Aspen's comprehensive effort to introduce aerogel based thermal insulation products into several key markets based on Aspen's new rapid aerogel drying technology. The new transparent aerogel insulation sheets will completely change the way windows, skylights and light transmitting structural panels are used in buildings and homes in the near future. There will be a significant increase in the use of windows and light transmitting walls. For example, one can have 5 cm (2 inch) thick aerogel insulation in a structural light transmitting wall with R-22 rating and daylight transmission of between 35 to 55%.

Proposed Team Members:

Aspen Systems, Inc.

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Insight Technologies, Inc.

Field Test of the Flame Quality Monitor

Need Area(s):

2.2 Space Conditioning Equipment: Distribution, Storage, Control, and System Integration

Abstract:

This project involves the development of the Flame Quality Monitor – an system which optically monitors the quality of a home heating system flame and signals the service organization when the quality of the flame has degraded to the point where service is required. For th homeowner benefits include increased efficiency as conditions which lead to heat exchanger fouling are detected early, improved reliabilit as problems are corrected before the systems stops providing heat, and avoidance of situations where combustion products and soot spil from the flue pipe into the residence. For service organizations this system provides greater customer satisfaction, and reduced service costs.

The system uses a photocell sensor in combination with a microprocessor based primary control to monitor the flame during normal cyclic operation. Flame condition, after warmup transients is compared with a setpoint, established during normal service. Drift of the signal more than an allowed amount from a setpoint triggers a service call. The service organization can be notified either using a local alarm, lin to an alarm system, modem, or internet connection.

In this project a 100 site field test will be done to establish the service cost savings associated with this technology. This information is seen as critical in the commercialization of this system. Project participants include Insight Technologies, Honeywell, Inc. and Brookhave National Laboratory.

Proposed Team Members:

Insight Technologies, Inc., with support from Honeywell, Inc. and Brookhaven National Laboratory

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Colorado State University

Phase Change Materials in Floor Tiles for Thermal Energy Storage

Need Area(s):

3.1 Building Envelope: Building Materials and Envelope Systems

Abstract:

This proposed interdisciplinary research project entitled “Phase Change Materials in Floor Tiles for Thermal Energy Storage” is for the development of a floor tile that can store significant amounts of thermal energy. Using such a tile in passive solar homes could significantl reduce heating energy consumption. Prototype tiles will be developed, manufactured and their performance will be tested. The expected trade-off will be tile durability versus thermal storage capacity. The project is sponsored by the Department of Energy and Colorado State University.

Proposed Team Members:

Colorado State University

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Arthur D. Little, Inc.

Application of Best Industry Practices to the Design of Commercial Refrigerators

Need Area(s):

4.2 Appliances: Other Appliances

Abstract:

A commercial reach-in refrigerator design will be developed which consumes about half the energy of today's typical units, while providin equal or better refrigerating performance with only a modest cost premium. The development will be done in close collaboration with our commercialization partner, the Delfield Company, a major manufacturer of food service equipment with a large share of the commercial reach-in market. Delfield will provide oversight and technical assistance for the project representing 160 hours of effort, as well as contributing hardware for testing and analysis. The substantial efficiency improvements which have been made to residential refrigerators over the last ten years as a result of the National Appliance Energy Conservation Act, and changing consumer attitudes towards energy savings, give an indication of the potential for improvement in the commercial sector, where few such efficiency improvements have been made. The proposed project will investigate the application of best industry practices used in the residential sector combined with capacit modulation technology to the design of a high efficiency commercial refrigerator. The purchase decision for commercial refrigerators is stil focused primarily on product performance such as maximizing storage capacity, quick temperature pull-down, durability, and reliability. DOE support will be needed to modify these market forces to include sensitivity to operating cost and energy use. Due to the fragmented nature of this market, the resource constraints of equipment manufacturers, and the lack of outside pressure (such as exists in the residential sector), development efforts to improve the efficiency of this equipment have been limited. The proposed program will apply technology used extensively to reduce energy use in residential refrigeration to improve a commercial reach-in refrigerator. The overall results should also be applicable to other commercial refrigeration equipment. A baseline refrigerator representing a design type widely used in commercial food service will be obtained from Delfield. A suitable test procedure for evaluation of refrigerator energy use and performance will be developed, which will include elements important for the commercial user such as pull-down and frequent door openings. The baseline refrigerator will be tested to benchmark its performance and to calibrate a computer model, which will allow rapid evaluation of a wide array of design options to reduce energy. An optimized design configuration, consistent with the project objectives, will be selected. A prototype will then be designed and fabricated. Testing of the prototype will allow direct comparison of its performance and energy use with that of the baseline unit. Upon completion of the project, the prototype will be delivered to Delfield for evaluation anc continued commercial development leading to product introduction in the year 2002. The assembled development team, including Arthur D. Little, Inc., the Delfield Company, and Thermodyne, Inc. is extremely well qualified to carry out this development successfully. Arthur D Little, Inc. has a large team dedicated to HVAC and Refrigeration technology with extensive experience in system design, and commercialization. Delfield supplies a substantial portion of the reach-in market and has been manufacturing high-quality refrigeration equipment for half a century. Dr. Varone of Thermodyne, Inc. has been involved in thermal analysis of refrigeration and air-conditioning systems using sophisticated computer models for nearly ten years.

Proposed Team Members:

Arthur D. Little, Inc., with the Delfield Company, and Thermodyne, Inc.

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Arthur D. Little, Inc.

Staging of Proton Exchange Membrane (PEM) Fuel Cell Stacks - PhaseII

Need Area(s):

5.1 Cogeneration: Fuel Cells

Abstract:

OBJECTIVES: To investigate means of enhancing the efficiency of stationary staged Proton Exchange Membrane Fuel Cell (PEMFC) power systems and optimize the membrane electrode assembly (MEA) structures used in the fuel cell stacks for staged operation. METHODOLOGY: Key to increasing PEMFC efficiency is achieving high hydrogen utilization at high voltage and acceptable power densities. In typical PEMFC stacks the concentration of hydrogen, oxygen, and other reactants varies considerably between anode inlet and anode outlet (tailgas). With most PEMFC stacks currently under development this necessitates a compromise in the optimization of th most important operating parameters: the cell voltage, the operating temperature, the membrane material, the electrode structure, and in most cases same flow passages. Arthur D. Little has developed the CELLSTAGE™ technology, in which the hydrogen is converted to power in several stack stages. By optimizing each stage for the local reactant concentrations a much more effective operation is achievable This efficiency can be translated into higher system efficiency, smaller required area (i.e. lower cost) or a combination of the two. In the Phase I program currently being completed, Arthur D. Little has proved the feasibility of the CELLSTAGE™ technology using computer models. The models indicate that substantial improvements in performance can be achieved by optimizing several of the key parameters. In addition, several advanced MEA technologies with higher temperature capability have been tested in a single cell stack for use in staged stack systems. In Round II Arthur D. Little is now proposing to experimentally verify and optimize the staged technology with full-sized fuel cell stacks. This will both prepare the CELLSTAGE™ technology for full-scale application and allow for optimization of the MEA structures for the membranes used and for staged operation at higher temperatures. The results could broadly benefit PEMFC technologies. The benefits will be quantified in our 50kW PEMFC powerplant model to reflect changes in total efficiency, power, size, weight and cost.

Proposed Team Members:

Arthur D. Little, Inc.

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EFI, Inc.

Development of Internet-Based Facilities Automation System

Need Area(s):

6.3 Whole Buildings: Smart Buildings

Abstract:

OBJECTIVES: Develop and test a customer-centered, Internet-based energy management system targeted at the small to mid-sized commercial facilities and multifamily residential buildings. Savoy Automation and EFI have teamed up to bring to market a cost-effective energy management system to the largely unserved market of small to midsize commercial and residential buildings. The WebEngineTM has already been developed. The WebEngineTM allows remote monitoring of multiple sites from a central location using the Internet. In the proposed project, the balance of system will be developed and tested. The balance of system consists of an energy monitoring module, web browser based control module, a module for uploading data to websites and extensive website development. All of this development needs to be extremely easy to use and must meet customer needs. We have, therefore, included tasks on "Quality Function Deployment" which is a method to identify and transfer customer needs to product design attributes to product features. Finally, the entire energy management system will be tested and a commercialization plan will be developed. Strategic alliances with several major manufacturers have been established for the WebEngineTM. Alliances include Cutler Hammer, Elk, Genlyte Thomas, IBM Home Director, and Radionics. These alliances will be further expanded as necessary to assure commercial success in the marketplace. Savoy Automation is the first developer of an energy management system that leverages the Internet to remotely control building equipment. As such, it has "First Mover" advantage. The team of EFI and Savoy Automation cover all aspects of the proposed effort. EFI's expertise in energy use, energy efficiency, Quality Function Deployment and commercialization process, combined with Savoy Automation's technical expertise, as well, as in starting companies and growing them provides full coverage for the development and commercialization of this energy management system.

Proposed Team Members:

EFI, Inc., with support from Savoy Automation